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Analyzing HEAT of Lesson Plans in Pre-Service and Advanced Teacher Education

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Abstract

Higher-order thinking, Engagement, Authenticity, and Technology integration combine to form HEAT to boost the rigor of a lesson plan to impact K-12 student learning. This preliminary study examines both pre-service and advanced teachers’ lesson plans to determine the level in each of the HEAT components. Through this study an instrument has been revised and refined using previous research of HEAT. The researchers assessed the current HEAT level of lesson plans at both the undergraduate and graduate levels. The findings show a difference in HEAT performance of the pre-service and advanced teachers’ lesson plans; however, Higher-order thinking was the highest component of performance for both groups’ lesson plans. In this preliminary study, Technology was found to be the strongest predictor of overall HEAT performance.

Keywords
Lesson Plan; Higher-Order Thinking; Engagement; Authentic Learning; Technology Integration; Teacher Education

Introduction

In many cases, educational technology use in the classroom is supplemental and solely for getting the attention of students. While teachers feel required to use technology due to state teacher standards, the way in which it is used is often dispensable. Similarly, as a need to satisfy university teaching standards, college instructors are perpetuating this problem by requiring technology to be “somewhere” in the lesson plans that pre-service teachers create as part of their course work, not realizing that they are contributing to the trend. Instead, technology use should be indispensable and inseparable from higher-order thinking, authenticity, and engagement when designing and implementing instruction. Such use can be found in standards like the International Society for Technology Education’s standards for teachers (ISTE, 2008) and students (ISTE, 2007), which advocate for a holistic and comprehensive approach to technology integration.

Schools have spent millions of dollars equipping classrooms with computers, high-speed Internet access, printers, software products, and many other resources. The role of technology has evolved from assisting the teacher in personal management and presentations to students creating products using technology with higher-cognitive learning in authentic contexts. If pre-service and in-service teachers are to take full advantage of the affordances of educational technology, they should earn degrees with the skills to seamlessly integrate technology to advance student learning.
The National Council for Accreditation in Teacher Education (NCATE) delineates responsibilities for teacher education programs for accreditation purposes. In Standard 1b, “Pedagogical Content Knowledge for Teacher Candidates”, the target rating is defined as follows:

Teacher candidates reflect a thorough understanding of the relationship of content and content-specific pedagogy delineated in professional, state, and institutional standards. They have in-depth understanding of the content that they plan to teach and are able to provide multiple explanations and instructional strategies so that all students learn. They present the content to students in challenging, clear, and compelling ways, using real-world contexts and integrating technology appropriately. Candidates in advanced programs for teachers have expertise in pedagogical content knowledge and share their expertise through leadership and mentoring roles in their schools and communities. They understand and address student preconceptions that hinder learning. They are able to critique research and theories related to pedagogy and learning. They are able to select and develop instructional strategies and technologies, based on research and experience, that help all students learn. (NCATE, 2008)

To meet the NCATE criteria for technology, many universities incorporate technology skills into the methods course and hope that pre-service teachers experience technology integration first-hand in the field. The National Center for Education Statistics’ 2007 report on education technology used in teacher education programs provides the following statistics about what pre-service teachers experience in these programs:

- Used Internet resources and communication tools in all or some of their teacher education programs (100%)
- Instructed on ways to integrate technology into lesson planning (99%)
- Utilized content specific software tools while teaching (97%)
- Used multimedia digital content for instruction (95%)
- Used technology for retrieving or organizing data to enhance teaching (90%)
- Taught to use technology for student assessment that aligned to state curriculum standards in all or some of their programs (88%)
- Utilized digital portfolios in all or some of their programs (82%)
- Instructed on utilizing technology for student assessment in all or some programs (79%)

Although these percentages appear promising, further scouting reveals that “…reports of topics taught within programs should not be taken to mean that the topics were taught in any depth or breadth across the curriculum. Rather the estimates only indicate that the topic was taught at least to a minimal degree” (Kleiner, Thomas, & Lewis, 2007, p. 6). The percentages dramatically declined when the universities were questioned to the extent in which teacher education programs incorporate technology instruction:

- 57% instructed pre-service teachers about how to use technology to augment classroom instruction;
- 17% instructed pre-service teachers on employing technology to assess student achievement;
- 17% trained pre-service teachers on designing instructional interventions to individualize instruction;
- 15% addressed how to utilize technology to accommodate for various student learning styles.

The U.S. Department of Education (2008) conducted a national research study to determine the level of integration of technology within K-12 schools. Their instrument included three broad categories: “Teacher Use of Technology”, “Student Use of Technology”, and “Students’ Use of Technology for the Critical Thinking and Decision-Making Skills Related to Technology Literacy.” Within the category of “Teacher Use of Technology,” the study reported that teachers used technology when developing curricula (31%), creating tests (31%), conducting research and lesson planning using the Internet (27%), and presenting concepts using technology (22%). The percentages decreased within the category of “Students’ Use of Technology”, as the survey reported that students used technology to extend learning in subject areas
with enrichment activities (22%), conduct online research (7%), and produce media, Web, or presentation products (2%). In the final category, “Students’ Use of Technology for the Critical-Thinking and Decision-Making Skills Related to Technology Literacy”, percentages were even lower. The survey results indicated that students used technology to work cooperatively with other students (8%), communicate electronically with others about academic content (5%), use inquiry-based strategies (3%), solve real-world problems (3%), work with content in multiple disciplines (3%), use authentic tools (2%), and create products that had a real world audience (1%). Based on these data, teachers and students in the classroom are rarely using technology for critical thinking in authentic contexts.

To further investigate the U.S. Department of Education study, Stobaugh, Tassell, and McDonald (2010) reviewed sample instructional design projects from 40 student teachers within various initial teacher certification majors at a southeastern university. Using an instrument similar to the one used in the U.S. Department of Education study (2008), the findings showed various ranges among the three categories: “Teacher Use of Technology” (8 to 65%), “Student Use of Technology” (0 to 38%), and “Students’ Use of Technology for the Critical Thinking and Decision-Making Skills Related to Technology Literacy” (0 to 5%). The researchers found that most pre-service teachers effectively integrated technology to present concepts to students in their lessons (90%). The other areas that scored high were using technology to develop assignments (65%) and to do research and lesson planning (58%). However, several items were not found in any of the samples. They were within the categories “Student Use of Technology” and “Student Use of Technology for Critical Thinking” and included “Work cooperatively or collaboratively with other students”; “communicate electronically about academic content with experts, peers, or others”; “work in content in multiple disciplines”; and “create products that had real-world audiences”. These data, similar to the U.S. Department of Education (2008) research, reveal the infrequent student use of technology for critical thinking and decision-making in real-world situations.

Concerns about technology use by teachers and students presented this institution with a need for further research in lesson planning and instructional design to increase the use of Higher-order thinking, Engagement, Authenticity, and Technology integration (HEAT). Graduate educational technology courses in the same southeastern university are primarily comprised of public school teachers. After instruction on the HEAT framework, the expectation was that lesson plans were to achieve a HEAT level of 3 or higher for all four components (see below for an explanation of the components and score levels). The concerns of the previous research by Stobaugh et al. (2010), coupled with the success of the graduate educational technology implementation of a HEAT framework, provided the foundation for this preliminary study.

**Purpose**

The authors believe in the potential to improve K-12 student performance through targeted levels of instructional design by pre-service and advanced teachers. One vehicle to achieve this is through the implementation of the HEAT framework in undergraduate and graduate university courses. The implication is that as teachers learn to design lessons at higher HEAT levels, higher K-12 student performance can be achieved. Previous research supports each component of the HEAT instrument as a catalyst for student achievement.

**Theoretical Framework**

The HEAT instrument developed by the researchers was used in scoring lesson plans developed by pre-service and advanced teacher education students at a university in the southeastern part of the U.S. It was originally based upon work by Moersch (2002) and expanded by the researchers using further studies. The HEAT instrument represents six levels of performance for four different variables: Higher-order thinking, Engaged learning, Authentic learning, and Technology integration (Table 1).

*Higher-Order Thinking (H)* is measured using the Revised Bloom’s Cognitive Taxonomy (1956). To meet the minimum target HEAT level of 3 or above, lesson plans must be rated at Bloom’s “Analyzing” level or higher (Krathwohl, 2002). In addition, Robert Marzano’s work has acted as a foundational cornerstone in
delivering high-quality teaching and learning in the 21st-century classroom and is included in the higher order thinking category of the HEAT instrument. In *Dimensions of Learning* (Marzano et al., 1992), cognitive thinking skills were identified and codified into writing techniques, thinking techniques, and general information processing strategies. These strategies have been perpetuated in classrooms, and Marzano (2010) reported positive results when coaching students to make inferences about processes. Inferential methods are routinely skipped or ignored by classroom teachers but are the foundation for higher-level thinking processes.

Using both Bloom’s and Marzano’s frameworks, the learning target or objective of a lesson can be raised to higher levels of cognitive thinking. As teachers raise the learning target of a particular lesson, it can be argued that instruction has improved. When objectives, activities, and assessments are properly aligned at higher levels of cognitive thinking, not only has instruction improved but student learning has a better chance of improving as well (Raths, 2002).

*Engaged Learning* (E) can lead to the acquisition of new skills (Connell & Welborn, 1991). Several researchers have identified and measured multiple facets of the construct. Miller, Green, Montalvo, Ravindran, and Nichols (1996) focused on students’ learning beliefs and expectations while Pintrich and Schrauben (1992) examined self-efficacy. Schiefele (1995) has examined task interest levels.

The indicators presented by Jones, Valdez, Nowakowski, and Rasmussen (1994) comprise the HEAT instrument’s Engagement category. In an engaged learning classroom, the role of the teacher is as facilitator, guide, and learner. The teacher also mediates, models, and coaches while participating with students as a co-learner and co-investigator. The student’s role is to be an ‘explorer’. Through this role the student discovers concepts, applies skills, and reflects upon the findings.

*Authentic Learning* (A) is measured by the relevance of objectives, instructional activities, and assessment as applied to the real world. Driscoll (2000) defines authentic learning as “a persisting change in human performance or performance potential… [which] must come about as a result of the learner’s experience and interaction with the world.” Herrington and Oliver (2000) pose that an ‘authentic’ learning environment provides authentic contexts that reflect the way in which knowledge will be used in real life, authentic activities as close to the real world as possible, access to expert performances and the modeling of processes, multiple roles, and perspectives, and authentic assessment of learning within tasks.

*Technology Integration* (T) is measured by indicators discussed by Moersch’s Levels of Technology Integration (LoTi) scale and was initially developed in 1995 to consistently assess the depth of integration across a demographic (Moersch, 2002). The authors included clarification across the knowledge levels as well as the interaction affects of higher-level thinking, engagement, and authenticity. The lower-levels of the HEAT Technology category define technology as a supplemental or complementary tool for the classroom while upper levels view technology as an integral component of the learning process.
### Table 1: HEAT Instrument*

<table>
<thead>
<tr>
<th>HEAT Levels</th>
<th>H Higher-Order Thinking (HOT) with Content</th>
<th>E Engaged Learning</th>
<th>A Authentic Learning</th>
<th>T Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. Non-Use</td>
<td>Lecture; students taking notes only; no questions asked.</td>
<td>Teacher directed completely; no student interaction.</td>
<td>No connection to real world.</td>
<td>No technology use is evident by students or teacher.</td>
</tr>
<tr>
<td>1. Awareness</td>
<td>Students are learning at Knowledge level of Bloom's Taxonomy.</td>
<td>Students report facts they have learned on tests or questions posed by teacher; one single, correct answer.</td>
<td>Contrived, real world problems using textbook or worksheets; short one-method, one-answer problems.</td>
<td>Teacher uses technology for demonstration or lecture.</td>
</tr>
<tr>
<td>2. Application</td>
<td>Students are learning at Remembering, Understanding, or Applying levels of Bloom's Taxonomy; teacher questioning.</td>
<td>Students are engaged in a task or activity directed by the teacher; multiple solutions accepted.</td>
<td>Learning experiences use real-world objects or topics and provide some application to the real world.</td>
<td>Technology use by students is unrelated to the task; technology is used for low-level cognitive tasks (Remembering and Understanding levels of Bloom’s Taxonomy).</td>
</tr>
<tr>
<td>3. Exploration**</td>
<td>Students are learning at Analyzing level or higher of Bloom’s Taxonomy; teacher questioning and directed instruction.</td>
<td>Students are given options for projects or to solve a problem posed by teacher; students are engaged in projects based on preferred learning styles or varied instructional strategies.</td>
<td>Learning occurs in a simulated real-world situation such as a class store.</td>
<td>Technology use appears to be an add-on and is not needed for task completion; technology is used for higher cognitive tasks like analysis and decision-making; technology provides adaptations or alternatives in activities, assessments, and materials for special populations.</td>
</tr>
</tbody>
</table>
Table 1 continued

<table>
<thead>
<tr>
<th></th>
<th>Integration**</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Student-generated questions/projects at Analyzing, Evaluating, or Creating levels of Bloom’s Taxonomy; multiple indicators of learning.</td>
<td>Students help define the task, the process, and the solution; students have options to solve a problem based on student questions; collaboration with others.</td>
<td>The learning experience provides real world relevance and tasks which can be integrated across subject areas; learning has a classroom or school emphasis and impact.</td>
<td>Technology use is integrated or connected to task completion; technology use promotes collaboration among students for planning, implementing, and evaluating their work; technology is used as a tool to help students identify and solve authentic problems relating to an overall theme/concept.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Expansion</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Students learning/questioning at Analyzing, Evaluating, or Creating levels of Bloom’s Taxonomy; complex thinking involves problem solving, decision making, reasoning, experimental inquiry, investigation, and reflection.</td>
<td>Students help define the task, the process, and the solution; collaboration extends beyond the classroom to community/field experts; opportunity to express different points of view through collaboration; collaborative construction of knowledge.</td>
<td>The learning experience provides real world relevance and opportunity for students to apply their learning to a real world situation; authentic assessment; access to expert thinking and modeling processes; learning has a local or community emphasis and impact.</td>
<td>Technology use is directly connected to task completion involving one or more applications; technology extends the classroom by expanding student experiences and collaboration beyond the school and in local community. The complexity and sophistication of the technology-based tools used in the learning environment are commensurate with (1) the diversity, inventiveness, and spontaneity of the teacher’s experiential-based approach to teaching and learning and (2) the students’ level of complex thinking.</td>
</tr>
<tr>
<td>6. Refinement</td>
<td>Student learning/questioning at Analyzing, Evaluating, or Creating levels of Bloom’s Taxonomy; complex, open-ended learning environment.</td>
<td>Students help define the task, the process, and the solution; collaboration extends beyond the classroom to global experts; student problem-solving and issues resolution are the norm.</td>
<td>The learning experience is directly relevant to students and involves creating a product that has a purpose beyond the classroom that directly impacts the students and an authentic situation; learning has a global emphasis and impact.</td>
<td>Technology use is directly connected and needed for task completion and students determine which application(s) would best address their needs; technology is a seamless tool used by students through their own initiative to find solutions related to an identified “real-world” problem or issue of significance to them; technology provides a seamless medium for information queries, problem solving, and/or product development.</td>
</tr>
</tbody>
</table>

*Revised 5/19/2010 by Maxwell, Stobaugh, and Tassell

**Exploration and Integration levels must be consistent and sustained over a period of time before Expansion and Refinement levels can occur.
Research Questions

The purpose of this research was to analyze the HEAT of lesson plans prepared by pre-service and advanced teachers in teacher education courses at a southeastern university. The research questions are as follows:

1. What percentage of lesson plans prepared by pre-service and advanced teachers score at a level 3 or higher in higher-order thinking activities?
2. What percentage of lesson plans prepared by pre-service and advanced teachers score at a level 3 or higher in engaged learning activities?
3. What percentage of lesson plans prepared by pre-service and advanced teachers score at a level 3 or higher in authentic learning?
4. What percentage of lesson plans prepared by pre-service and advanced teachers score at a level 3 or higher in technology activities?

Methods

The authors believe that both pre-service and advanced teachers are capable of learning to create lessons at a HEAT level of 3 or higher. In two undergraduate methods courses in the spring 2010 semester, pre-service teacher education students were required to create lesson plans as part of the typical course requirements. In an elementary methods course, the pre-service teachers were required to utilize the HEAT document in creating at least one of four required lesson plans. In an elementary math methods course, pre-service teachers were required to create a problem-solving math lesson; they were encouraged to implement the HEAT document, but it was not a requirement. Forty-two pre-service teachers’ lesson plans from the two courses were collected for HEAT analysis. Thirty-four lesson plans of advanced teachers in a graduate educational technology course were also included, so that in all, 76 lesson plans were studied.

The researchers began with a draft HEAT instrument, working together to revise and apply it to a sample lesson plan. The sample lesson plan was an “average” lesson plan according to the professor from whose course it was collected. Through discussion it became clear that the three researchers did not have the same prior knowledge, understanding, and interpretation of the HEAT components. Hence, through conversations the researchers articulated each component more precisely and revised the HEAT instrument to reflect these more detailed definitions.

An interesting finding was the similarity in which lesson plans scored on certain components of the HEAT instrument. For example, if H scored at a level of 3 or 4, then T scored at the same level. Upon scrutinizing the HEAT instrument, similar language was found in both components. In this case, the T category contained language about cognitive thinking. Consequently, the T component was revised to better represent technology use by teachers and students and its relation to or necessity in instruction. After this adjustment, it was possible to score H and T independently of each other.

Another interesting connection existed between E and A. Again, researchers found that as scores went up for one component, they went up for the other as well. Similar language was found in both categories, and the A category was revised to more closely reflect the relationship between learning and authentic, real-world connections. The E component was rewritten to reflect how engaged students are in learning, including items such as options in projects, collaboration with other students or outside experts, and how involved students are in defining and implementing their own learning tasks, processes, solutions, and assessments.

In determining the inter-rater reliability for this study, the researchers scored six randomly selected lesson plans from the sample group. After each rater scored the lesson plans, differences and variations in individual ratings were discussed at length. These discussions resulted in the refinement and enhancement of the HEAT scoring criteria and rubric.
Using the refined rubric, the researchers randomly selected a final set of lessons plans to serve as the baseline for estimating inter-rater reliability. The SAS macro routine %INTRACCC was used to calculate inter-class correlations on the final lesson plan ratings. The SAS routine computes intra-class correlations discussed in Shrout and Fleiss (1979) and intra-class correlations using formulae from Winer (1971). The inter-rater reliability, from the final set of lesson plans scored with the refined rubric, was calculated at .636. Coefficients within the range of .40-.60 are typically thought to indicate good agreement (McDowell, 2006). As this study is preliminary and has only a limited number of raters and trials, the researchers judged the reliability calculation as sufficient.

Data Analysis

In preparation for analysis, student names were removed from the lesson plans, which were then numbered and divided by a graduate assistant. Hence, each researcher conducted blind reviews of one-third of the lesson plans using the HEAT instrument and recorded scores in separate Excel files. The Excel files were then compiled into one data set and imported into SAS. To address the research questions of this study, frequencies and percentages were calculated.

Results and Discussion

Table 2 displays the overall results of the data analysis, with the results for each HEAT component discussed in further detail below.

Table 2: Frequencies and Percentages for Lesson Plan Scores Using the HEAT Instrument (N = 76)

<table>
<thead>
<tr>
<th>HEAT Level</th>
<th>Higher-Order Thinking</th>
<th>Engagement</th>
<th>Authentic Learning</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-service Teacher (n=42)</td>
<td>Advanced Teacher (n=34)</td>
<td>Total</td>
<td>Pre-service Teacher (n=42)</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>2 (5%)</td>
<td>0</td>
<td>2 (3%)</td>
<td>3 (7%)</td>
</tr>
<tr>
<td>2</td>
<td>13 (31%)</td>
<td>1 (3%)</td>
<td>14 (18%)</td>
<td>33 (79%)</td>
</tr>
<tr>
<td>3</td>
<td>27 (64%)</td>
<td>28 (82%)</td>
<td>55 (72%)</td>
<td>6 (14%)</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>5 (15%)</td>
<td>5 (7%)</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Meeting Target*</td>
<td>27 (64%)</td>
<td>33 (97%)</td>
<td>60 (79%)</td>
<td>6 (14%)</td>
</tr>
<tr>
<td>Mean</td>
<td>2.60</td>
<td>3.12</td>
<td>2.83</td>
<td>2.07</td>
</tr>
</tbody>
</table>

*i.e. scoring at level 3 or above.*
Research Question #1: Higher-Order Thinking

When considering all HEAT scores, for both the group as a whole as well as the pre-service and advanced teacher subgroups separately, higher-order thinking was the highest scoring component. For a target score of 3, the lesson plan needed to include: "Students learning at an Analyzing level or higher of Bloom’s Taxonomy; teacher questioning and directed instruction." Some lesson plans (18% - all but one of these were from pre-service teachers) scored at a level 2: "Students learning at Remembering, Understanding, or Applying level of Bloom's Taxonomy; teacher questioning." Five lesson plans (7% of the overall group) in the advanced teacher group scored at a level 4: "Student-generated questions/projects at Analyzing, Evaluating, or Creating levels of Bloom’s Taxonomy; multiple indicators of learning." The results confirm the emphasis on higher-order thinking in instruction on lesson plan design, which is the focus of the undergraduate courses.

Research Question #2: Engaged Learning

For the overall group, engaged learning ranked third out of the four performance components with regards to lesson plans meeting the minimum target score. Only 14% of the pre-service teacher group met the target score of 3. To achieve a 3, the lesson plan had to include: "Students are given options for projects or to solve a problem posed by teacher; students are engaged in projects based on preferred learning styles or varied instructional strategies." While a large portion (91%) of the advanced teachers wrote at a level of 3 or 4, the majority of pre-service teachers (79%) performed at level 2. This leads to the conclusion that many of the pre-service teachers were not proficient in planning for student engagement by building in options for solving problems or working on projects.

Research Question #3: Authentic Learning

The overall sample scored the lowest (43%) on the authentic learning component, and a sizeable difference in performance existed between the advanced teacher (82% at target) and pre-service teacher (12% at target) groups. To reach level 3, the lesson plan needed to include: "Learning occurs in a simulated real-world situation such as a class store." In contrast, 38% of the overall sample scored at level 2, where plans included: "Learning experiences use real world objects or topics and provide some application to real world." Finally, 17% of lesson plans scored at level 1, as they consisted of "Contrived, real world problems using textbook or worksheets; short one-method, one-answer problems." Pre-service teachers’ lesson plans made up the majority of these, as they are still developing their thoughts and ideas about how to use existing curriculum and materials and tended to gravitate toward pre-designed materials that lacked authenticity but may very well still have higher-order thinking involved.

Research Question #4: Technology

With regards to reaching the target score of 3, the technology component was the second highest scoring component for the overall sample of lesson plans (54%); while the graduate group scored very high (94%), the pre-service teacher group lagged behind (21%). To obtain a level 3 score, the lesson plan needed to include: "Technology use appears to be an add-on and is not needed for task completion; Technology is used for higher-cognitive tasks like analysis and decision-making. Technology provides adaptations or alternatives in activities, assessments, and materials for special populations." Some lesson plans in the overall group (12%) scored at level 2, indicating: "Technology use by students is unrelated to the task; Technology is used for low-level cognitive tasks (Remembering and Understanding levels of Bloom’s Taxonomy)." In addition, 26% (all undergraduates) of the lesson plans only received a score of 1: "Teacher uses technology for demonstration or lecture." Moreover, a small percentage (8%), comprised of pre-service teachers, scored at level 0 -- no technology used. This outcome seems to confirm the idea that for pre-service teachers, technology is a skill that is rarely modeled or used in the ways that are described at level 3 in the HEAT instrument. Many pre-service and advanced teachers are also still at the level of teacher use of technology and have not yet fully incorporated student use into their lesson plans.
Finally, the highest possible holistic score for a lesson plan was 24; the minimum target score was 12 (i.e. four times the target score of 3). The highest holistic score achieved was a total of 16 by one advanced teacher. Clearly, pre-service teacher performance was lower for each component in comparison to the advanced teachers. Because undergraduates are still learning, there is more opportunity for growth, especially with more intentional focus on using the HEAT instrument to aid in the development of lesson plans. While advanced teachers did show a stronger performance, with 76% reaching a level of 3 or above in every category, only a few were scoring in the 5 to 6 range in any of the HEAT component, indicating that advanced teachers can also improve their instructional design by striving to reach higher levels of HEAT in their coursework.

Implications

“Raising the HEAT” of a lesson plan may seem like a simplistic metaphor. However, when reading a lesson plan that is considered to be proficient in all HEAT components, it will be apparent that the dynamic interaction of these components has the potential to increase student learning. In this study, when a lesson plan scored at a level 3 or higher for each of the four components, the instructional design tended to be cohesive and genuine, and devoid of contrived or artificial learning experiences.

When the HEAT instrument is used to evaluate the quality of lesson plans, pre-service and advanced teachers are called to higher levels of performance and design. As K-12 teachers get into the habit of designing instruction that consistently includes opportunities for higher-order thinking, student engagement, authentic learning, and technology integration, student performance can do nothing else but improve. The key is to find the right combination of the four components to maximize student learning in all grade levels and subject areas. Therefore, this research has the potential to improve the quality of instructional planning.

Further Research

With an eye toward further refinement of the HEAT instrument, additional analysis has already sought to determine if the HEAT instrument is sensitive to the instructional focus in coursework, i.e., does it measure HEAT elements of lesson plan design that are taught in the classroom? Initial results for pre-service teachers seem to indicate that when their lesson plans scored higher on technology, the overall HEAT level was higher. For advanced teachers, authentic learning is the best predictor of overall HEAT levels. Future research will more closely investigate predictability of composite HEAT scores from individual component scores.

Furthermore, validation of each individual component of the HEAT instrument will be a focus of future research, as well as possible effects they may have on each other (as mentioned in the Methods section of this article). The researchers will also study whether holistic scores are more meaningful than individual component scores, and whether they would be a valid yard stick for lesson plan evaluation and discussion in college classrooms and beyond.

Revision of the HEAT instrument to strengthen the theoretical base for each component is also a focus of continuing research. To clarify the HEAT the levels of each component, examples will be provided to assist instructors in their teaching and teachers in their lesson plans design. An example of a lesson plan summary that shows a level of 5 for all HEAT components (including an example of a student product) is provided in Table 3.
Table 3. Lesson Plan Summary with Identified HEAT Levels

<table>
<thead>
<tr>
<th>Grade 9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authentic Topic:</strong> Teen Bullying and Violence</td>
</tr>
<tr>
<td><strong>Lesson Plan Summary:</strong> After studying causes of teen bullying and violence, collaborative teams of ninth grade students will propose a plan (H) to address teen bullying in their school or community (A). You must collaborate with community resources (E) and two or more appropriate technologies (T).</td>
</tr>
<tr>
<td><strong>Sample project created by one team of students:</strong> One team of students developed a Character Education skit and presented it to grades 3-6 with emphasis on avoidance of bullying and violence. Then they created a “Safe Zone” blog to provide a safe place for kids to talk. Through the blog the team monitored and mentored elementary students about bullying events in their lives. The counselor from the Teen Violence Center collaborated with the team in their responses to elementary students' problems. The teacher actively reviewed the team's progress and advice to elementary students regularly.</td>
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<td><strong>Analysis of HEAT levels of this team's project:</strong></td>
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<td>H – 5; students use complex thinking in analyzing the type and frequency of bullying that affects elementary and middle grade students; decision making skills in what to include in the Character Education skit; the team created multiple versions of the skit appropriate for each grade level and acted out the skit for elementary classes</td>
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<td>E – 5; students designed their message, presentation format, sought counselor from the Teen Violence Center for advice and assistance in mentoring the elementary students on the “Safe Zone” blog</td>
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<td>A – 5; Bullying is a “real” issue for teens and pre-teens; presented to a group outside of their own school; impact beyond their own school through interactions with elementary students</td>
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<tr>
<td>T – 5; The electronic blog format was chosen as a more inviting anonymous methods of posting their bullying concerns; the team also created a screencast for training purposes for students in grades 3-6 demonstrating how to use the blog.</td>
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</tbody>
</table>

Finally, we will continue to use the HEAT instrument to score pre-service and advanced teachers’ lesson plans in our coursework to determine if HEAT levels increase when students are exposed to specific instruction of the HEAT instrument. In addition, we will continue to collaborate to research modeling of the HEAT framework in pre-service and advanced teacher courses and to improve its use. Once we are confident in the validity of our instrument and pre-service and advanced teachers are consistently designing instruction at a level 3 or higher, it is time to research the ultimate goal of our work: the effect of higher-level HEAT lessons on student learning.

References


